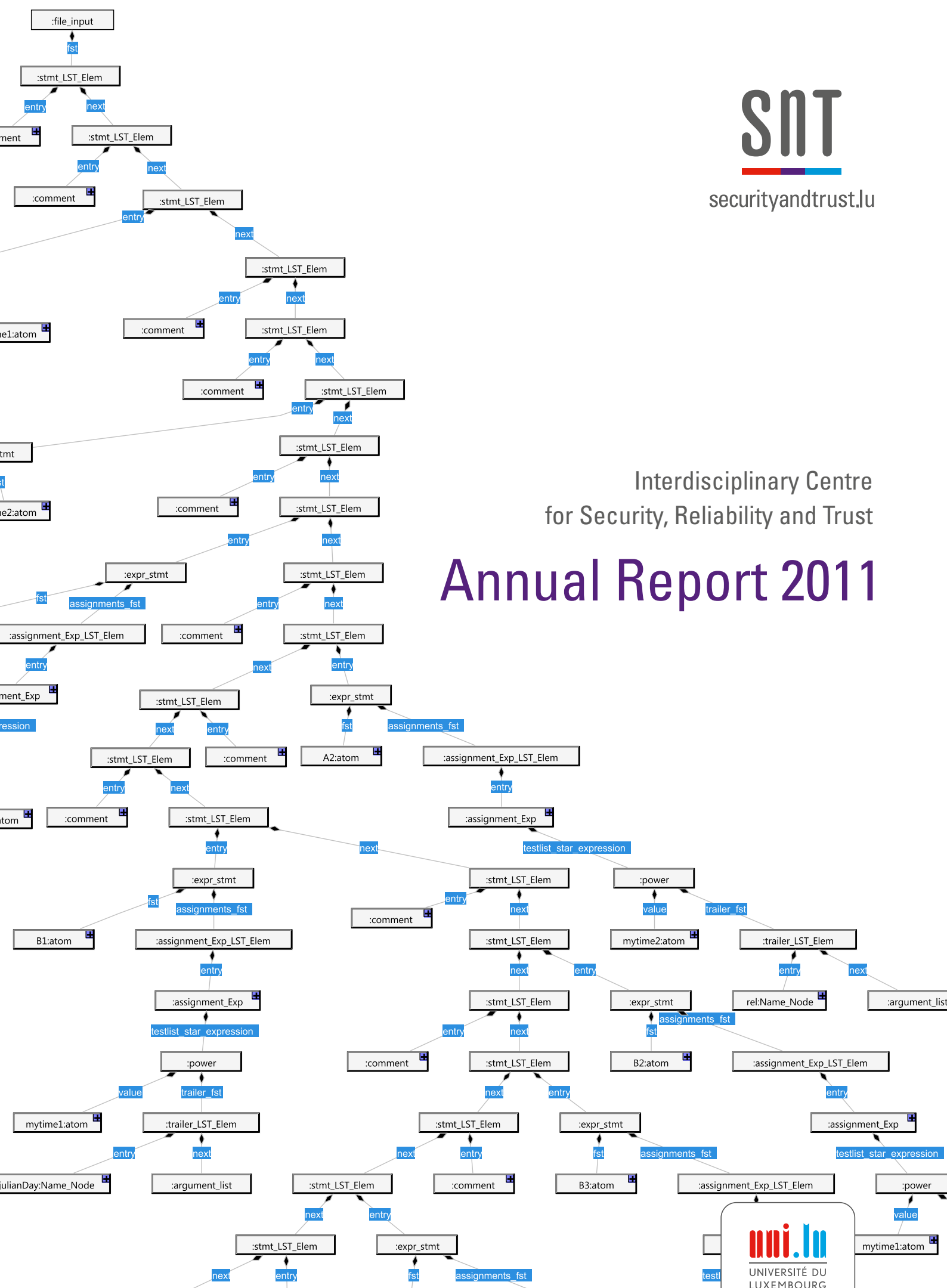




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Interdisciplinary Centre
for Security, Reliability and Trust

Annual Report 2011



Partnership Programme

Members of the SnT Partnership Programme



In the field of Information and Communication Technology (ICT), SnT is committed to promoting innovative ideas, increasing the depth and breadth of competence, as well as, facilitating research in collaboration with established partners from industry and the private sector, and ICT start-ups.

Through its Partnership Programme, SnT's partners contribute to and influence SnT's development at every level. The partners are represented on SnT's Board, which is concerned with the Centre's strategic development. The Industrial Advisory Board is charged with supporting SnT's strategy and operations. Research projects benefit from know-how and resources contributed by both SnT and its partners.



Editorial



Prof. Dr. Björn Ottersten
Director



Prof. Dr. Thomas Engel
Vice-director

Since its inception in 2009, the SnT has grown both rapidly and lastingly. In an effort to ensure that SnT's research output has relevance for as well as a strong impact on Luxembourg, our main focus has been on developing SnT's research activities through our Partnership Program. In all, SnT has entered thirteen separate partnership agreements with representatives from industry as well as the public sector. Of these, seven were added in 2011 alone, with a combined volume of approximately 2.5 million Euros. Another of SnT's priorities has been a strong focus on our European research initiatives to underscore Luxembourg's scientific competitive edge on a European scale while allowing the country to benefit from these international research programs. Over the past year, SnT managed to secure seven EU and three ESA research initiatives in the total amount of 2 million Euros.

The FNR is the Centre's most important source for external research funding and FNR projects represent investments in long-term research. The resulting research output and competence can be exploited later in the form of projects in collaboration with the country's industry and/or our various European partners. In addition to several FNR AFR grants and accompanying measures, six FNR CORE projects totaling 3.7 million Euros were awarded this past year. Recently, SnT was also awarded an FNR PEARL grant - the first ever to be given to the University of Luxembourg. The money from this grant has allowed us to launch, in January 2012, the Verification and Validation Laboratory headed by Pro-

fessor Lionel Briand, one of the world's leading scientists in the field of software verification and validation. Besides Briand, many other highly committed researchers - from doctoral students to senior scientists - have become a part of the growing SnT family. Deciding factors, which have helped attract these high-caliber individuals to Luxembourg and SnT include excellent resource availability as well as an atmosphere of creative optimism in which research becomes a highly enjoyable experience.

The enjoyment that comes with being part of a team of world-class scientists, the resulting confidence, and the potential to collaborate with our external partners: to meet the interdisciplinary research challenges of our joint projects, a number of strategic research programmes are being developed around our large-scale partnership agreements. We would like to thank our partners and sponsors for their loyal support throughout 2011.

This annual report presents a few brief research highlights and contains a comprehensive list of SnT's publications and projects, as well as a complete staff directory. We hope that you will enjoy discovering SnT in these pages.

Prof. Dr. Björn Ottersten
Director

Prof. Dr. Thomas Engel
Vice-director

Table of content

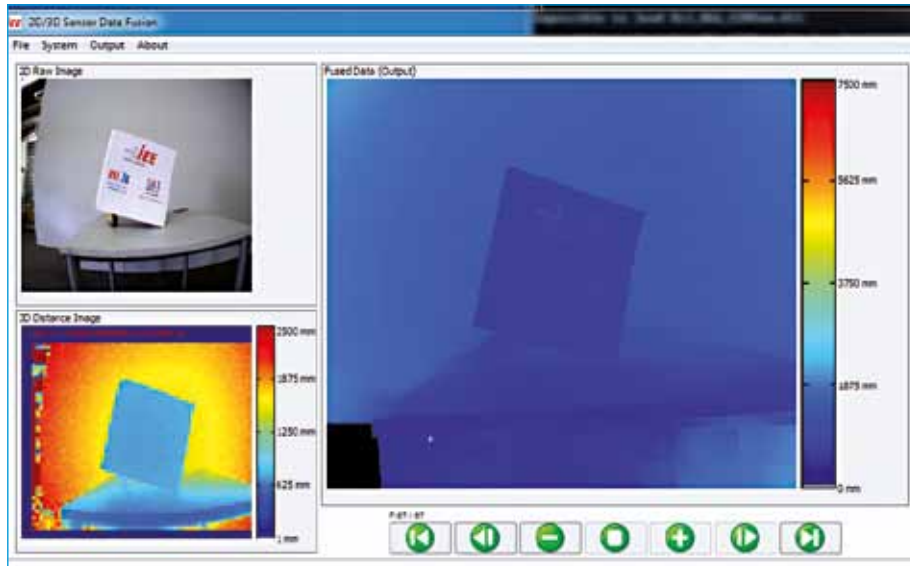
Innovations for wireless sensor networks: David Fotue	5
Sensor Fusion Lab: Making security technology intelligent	6
Privacy on the internet: Analysing network traffic	8
Automation Lab: The intelligent electric car	10
EU Project: LiveCity	12
SPELL: Satellite communication's Lingua Franca	14
Björn Ottersten: The team creates the success	16
Data protection: Two worlds collide	18
Security design and validation: The software triad	20
New at SnT: Lionel Briand	22
SnT advisory board: The view from outside	23
ESA Project: The Satellite MIMO Hardware Demonstrator	24
PhD candidates at SnT: International and interdisciplinary	26
Net Power Lab: Communication on the meta-level	28
Making Android safer: Alexandre Bartel	30
Organisation of SnT	31
Financial data	32
People and awards	34
Projects	36
Events	39
Publications	40
Cryptology: Alex Biryukov	46



Air pollution is a major global issue. David Fotue uses sensors that are part of urban wireless networks like Luxembourg's HotCity Network to measure air pollution. His goal is to design a network architecture that uses these types of sensors for real-time measurements of NO₂ and other air pollutants. Fotue's sensors are equipped with omni-directional antennas for transmission and reception and are linked together via Wi-Fi connections.

The way in which the information that the sensors pick up gets routed to the central workstation, or sink, strongly influences energy consumption and network lifetime. Each data packet requires a certain amount of energy. Inefficient routing affects the energy reserves of sensors in the sink's vicinity because these aggregate data from more distant sensors. Fotue's ultimate goal is to find a way to evenly distribute data traffic across the entire network thereby increasing network lifetime.

Making security technology intelligent



Foucault's Pendulum, a novel by Umberto Eco, opens with the narrator, Casaubon, hiding one night in the Musée des Arts et Métiers in Paris waiting for the building to be locked up. Convinced that the museum is the site of nightly gatherings of the Order of the Knights Templar, Casaubon is determined to reveal their secret. When Eco's book first appeared in 1988, security technology was still miles away from today's standards. These days, there is practically no way any visitor could get away with hiding unnoticed in a museum.

This is due in part to technology that SnT is developing together with Luxembourg-based sensing specialist IEE. »Our 3D MLI Sensor™ solutions like the People Counter, which features developmental work from SnT, are very successful,« says Dr. Bruno Mirbach, Algorithm Group Leader at IEE. A People Counter is currently installed in Brussel's Musée Magritte (MRBAB). »With the People Counter, the MRBAB can not only ensure

that it adheres to the regulations governing maximum occupancy levels but it also has a more accurate view of overall museum attendance, as well as, being capable of identifying which exhibitions receive the highest number of visitors, « says Mirbach.

Counting people in a museum may sound simple at first – but, as Mirbach explains, it is far from it. »Our People Counter has to be highly accurate in order to effectively calculate the number of people present in a room, floor, or building at any given time. Even in crowds, where people partially occlude each other, each individual person has to be segmented from the others and their trajectory tracked. For the system to function reliably, we needed entirely new algorithms, which have been developed based on methods obtained as part of a PhD project conducted at SnT.«

According to SnT's director, Professor Björn Ottersten, as part of the strategic partnership with IEE and other industrial partners, SnT is responsible for the basic research that goes into the project. »We are familiar with the current state of research, we know where the developmental lines are drawn, and we know what is scientifically possible and necessary in technological development. On this basis, we generate new knowledge, which our industrial partners then incorporate into their products as they are being developed« – such as programmes capable of helping IEE's sensors accurately count people and monitor occupancy levels. SnT is also developing methods for the fusion of 2D and 3D cameras, which a



Dr. Djamila Aouada

workgroup led by SnT researcher Dr. Djamila Aouada is working on.

»IEE has developed a 3D sensor based on the optical time of flight principle that can capture depth information – albeit at relatively low resolution and with a high level of noise,« says Djamila Aouada.

»As part of Frederic Garcia's PhD project here at SnT, we have created algorithms capable of combining real-time data from this 3D sensor with the data from a 2D camera, which has allowed us to obtain significantly higher resolution 3D images with reduced noise and artifacts.« Adds Bruno Mirbach: »The results are very impressive and highly relevant to the advancement of IEE's 3D Sensor.« What they need to do now is increase the resolution, the sensor's range, and the number of 3D images delivered per second even further – plenty of work for the SnT researchers and IEE's product developers.

According to Djamila Aouada, being able to analyse biometric data from the

hybrid 2D/3D camera will be a particular challenge. The long-term goal is to explore the data captured by this camera for the purposes of automatic action and facial recognition as in security zones. Naturally, this raises a number of privacy issues. It must be ensured that the data are used exclusively for the intended purpose and that people are not monitored without their prior authorisation. »We have factored this issue into our research right from the start,« says Djamila Aouada, who sees SnT as the ideal site for this type of research. »Here at SnT, we collaborate very closely with privacy experts, legal professionals, and psychologists. By doing so, it allows us to account for legal or psychological concerns in the early stages of research« – with the ultimate goal that, in the future, the results can be used for product development by SnT's strategic partners like IEE.



Analysing network traffic - so as to make it non-analysable



As far as the Internet goes, Andriy Panchenko is definitely a realist. »A search engine you use regularly probably knows more about you than do some of your best friends,« explains the SnT computer scientist whose work focuses on online data privacy and data security issues. »Everyone should by now be aware that today's search engine operators make their money through advertisements and therefore try to collect and make use of as many of their users' data as possible.« If - on top of all that - you also have a personalised email account run by the same company that operates the search engine, using cookies or computer recognition (in other words, your computer's IP address) to interconnect all the pieces of collected data and assigning them to one single individual becomes child's play. What if these data are leaked or at some point

- legally or illegally - passed along to some third party?

Panchenko also sees little reason for optimism where encryption and anonymisation are used in an alleged effort to ensure someone's online privacy. »Even if you assume that the encryption cannot be broken and only analyse the meta information that is present in each data stream when someone tries to access some website, you can already easily figure out who has looked at or exchanged what web content.« This could become a real issue, for example, in electronic elections where people's ballots are cast - even if their data are encrypted.

The situation may become life-threatening outside of the realm of Western democracies: »For those living under a

totalitarian regime, people's lives may depend upon their remaining anonymous and going unrecognised - for example, if the Internet is used to publish content that is government-critical,« Panchenko explains. All the more reason for the post-doc to approach the issue systematically and investigate it scientifically. The technique Panchenko uses to figure out where Internet anonymity is especially vulnerable and how to improve ways of protecting people's online privacy is called network traffic analysis. For this type of analysis, Panchenko assumes two roles at once. For one, he purposely leaves traces in cyberspace the way internet users would. Plus, he also leaves, analyses, and categorises his own traces to figure out how they might be detected.

Panchenko's traces are left by the computers that are crawling the web. Interposed between these computers and the websites visited are other computers called anonymizer nodes. »Anonymizer nodes are computers through which internet traffic flows and which are used to disguise the real sender's IP address,« Panchenko explains. At this point, all this is actually standard operating procedure based on a kind of 'onion-like' encryption. Originally developed for use by the US military, volunteer programmers have continued to develop, research, and fine-tune the technology. As such, internet traffic is transmitted through these anonymizer nodes, of which each one only knows its immediate neighbors - similar to the peels of an onion. »The IP address is no longer identifiable starting at the



Dr. Andriy Panchenko

first anonymizer node, which is the one located closest to the user's primary surfing computer. No single computer in the chain knows both the sender and the recipient,» Panchenko explains. And thus the user remains anonymous.

At least that was the opinion held by the online and research communities up until Fall 2011 - at which point Andriy Panchenko blew this assumption out of the water when he published groundbreaking results showing that state-of-the-art anonymisation networks do not in fact offer the promised protection. »What we did was look closely at the traffic between a user computer and the first anonymizer node,« says Panchenko as he describes his discovery. »More specifically, we analysed the open meta data that accompany any online data stream - such characteristics as packet size, order, or time intervals between packets.« These data are then fed into

a special programme called a classifier. Essentially, the SnT scientists 'train' the classifier to recognise certain recurring internet traffic patterns that might offer clues as to which websites are being accessed - data size, frequency of requests and replies - harmless, meaningless information. »As soon as the classifier has become 'smart' - we cross-reference the clues it gives us regarding specific web content with our actual surfing behaviour.« It turns out that Panchenko's classifier was able to provide highly accurate information regarding which websites the scientists had accessed - in spite of the presence of anonymizers and encryption.

Of course, Panchenko was not satisfied with stopping at the problem analysis stage. »These insights provided clues as to how we might be able to ward off future alarming breaches of security to protect internet privacy.« He has since

developed a new anonymizer, which he named 'Shalon.' The programme takes the plain data, encrypts it using the 'onion peel' approach, and finally tunnels it through anonymizer nodes. Unlike earlier approaches, Shalon is exclusively based on standardised protocols, is very lightweight, and is therefore universally applicable. According to Panchenko, »Shalon is one step in the right direction towards improving online privacy while increasing both the speed and the throughput of data protection technologies.« Others are bound to soon start circulating throughout the online community, which is always very quick to develop fixes and propose new solutions once weak spots have been identified.

The intelligent electric car



The e-car. Everyone is talking about it. Politically speaking, it is a top priority among tomorrow's mobility solutions. The race towards who will be the one to come up with the first viable model is one defined by intense one-upmanship among the various car manufacturers. But is a viable model even a possibility at this point in time? »The decidedly limited range of electric vehicles that run on a single battery charge is still a critical issue,« explains Holger Voos, SnT researcher and professor at the University of Luxembourg's Faculty of Science, Technology and Communication. But - according to Voos - the e-car's range is merely one of several concerns if the e-car is to become the new mode of transport of the future. »Energy efficiency, safety, riding and driving comfort, and even, to a great extent, communication are all being cited as major concerns.«

Voos believes that these concerns are all interrelated. »Range can be increased through battery improvements, a light body, and maximum energy efficiency.« The trouble is that lightness of body, in turn, directly affects vehicular safety. Voos believes that the way to get around this issue is by integrating advanced driver assistance systems (ADAS), in other words, by creating 'intelligent' cars. »In terms of safety and comfort, ADAS already today support drivers in conventional, petrol-fueled cars - for example, through electronic stability programmes and the brake assist feature.« These driver assistance systems strategically integrate different sensors, actuators, electronic components, and software-based automation functions.

Voos goes on to explaining that, as it were, driver assistance systems for electric cars would have to be different from ones that exist already. »ADAS for electric cars should increase both the vehicle's energy efficiency and its safety. At the same time, the sensors and electronic components themselves, too, will need to become as energy-efficient as possible - and thus far there has never been a need for that.« Yet it has to happen if we are to see more electric cars on our streets in the future. Which is why Holger Voos has set up an automation lab at SnT, which will systematically address, among other issues, that of ADAS tailored for electric cars. »We will be getting the first ever of the new generation of E-Smarts in Luxembourg early this summer,« says Voos.

The plan is that the new E-Smart will undergo rigorous testing at SnT's Automation Lab and that it will become the prototype for new driver assistance systems. As a first step, Voos will be looking especially closely at driver operating features as the key to energy-efficient travel. »We will adapt the sensors in the vehicle specifically for this purpose. This would give the driver an early heads-up as to how to optimise the range of his or her vehicle's battery,« says Voos.

This could be done, for example, by using systems that keep an electronic eye on traffic (»Bottleneck after the next turn - slow down!«) or anticipate the terrain





Prof. Dr. Holger Voos



ahead («Downhill grade ahead - slow down again!»).

To develop these new advanced driver assistance systems, Voos' Automation Lab at SnT is working closely with IEE, the Luxembourg-based developer of safety technologies and sensor systems for automakers. «Both SnT and IEE view the development of special sensor systems for electric cars as an important technological challenge for the future,» explains Voos. «Together, we want to be the first

to develop new concepts for practical application.» The conditions at SnT are conducive to Voos' research. «We will be instrumental in further advancing the process towards electronics taking charge of the vehicle. At the same time, it is critical that we take SnT's concerns of security and reliability into account right from the get go.»

Guaranteed quality for video-to-video applications



How do you get to know Athens via the Internet? You could simply open your web browser, type 'Athens' into your favourite search engine, hit 'enter,' and your screen will - in a matter of seconds - be flooded with pages upon pages of references and images about the Greek capital. Or, alternatively, you could just pick up a printed travel guide, which - arguably - would be far more enjoyable to look at. The catch: you won't really get to know Athens using either approach.

Dr. Rod McCall is a computer scientist at SnT who specialises in human-computer-interaction. He is part of SnT's new EU project 'LiveCity,' a partnership between several European organisations including SMEs, telecom providers, and universities. »'LiveCity' is our vision«, McCall explains. » We want people in Luxembourg to really get to know Athens using novel online video technologies and vice versa.« The consortium's focus is on how this vision might be developed. »Our goal here at SnT is to create an online location-based mixed reality game that people in both cities can play simultaneously using mobile phones and multi-touch displays,« McCall says. »People from Luxembourg and Athens could be hunting for objects, buildings, lifestyles in each other's cities even though they are separated from each other by some 2,000 km!«

Among the key challenges for the researchers are how the game will look and how it can attract players' interest and keep them engaged over the long term. For the 'LiveCity' project, the idea of a

mixed reality game is really only a means to an end. »What we're really trying to do here is test new technologies that could change how we deliver interactive video content both via fixed line and mobile technologies,« McCall explains. The approach will make for better mobile Internet experiences thereby allowing people to leave the shackles of their desktop PC behind and enjoy feature-rich experiences in the street. Herein, then, lies the fundamental challenge, according to McCall: »In order to make this vision a reality, the relevant technology has to first be developed while taking into account usability and data privacy issues.« Therefore the scientists have a challenging timetable: Work on the LiveCity started in early 2012 – with a demonstration game scheduled for release in Luxembourg in 2013.

Although game design is a huge challenge in itself, who will ultimately benefit from this technology? To answer this question, McCall uses another example system from LiveCity. »The hour following an accident is the most critical for the victim; with the care that is available in the ambulance often determining the fate of the patient.« Simple logistics dictate that it would not be possible for every ambulance to have all the available medical specialists on board who are capable of assessing or treating the patient. However, this problem could potentially be solved if high-quality video transmission technology was readily available. »Imagine if a specialist located at any other hospital in the country could be made available to



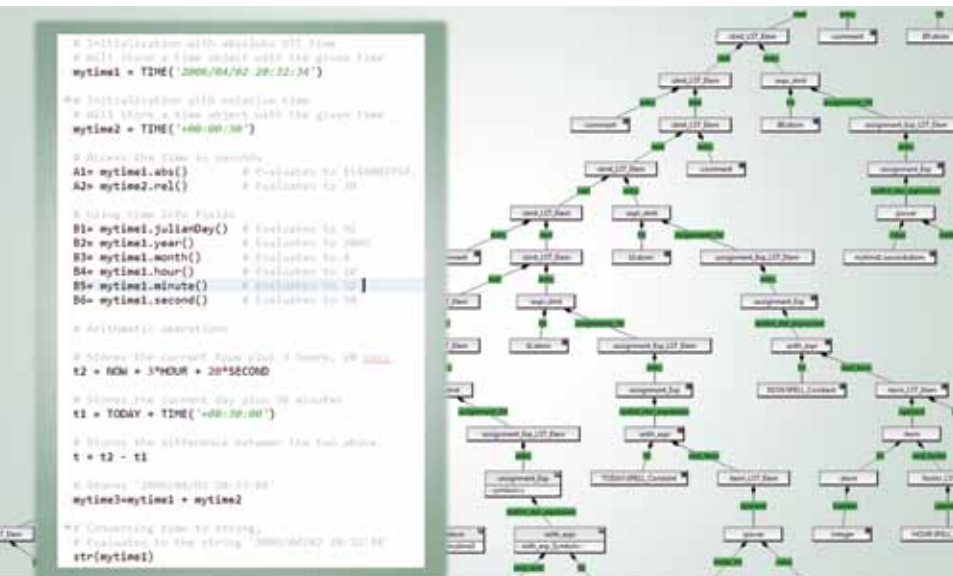
Dr. Rod McCall

the paramedics via a reliable interactive video link. The specialist would be able to not only see the patient but also guide the paramedics on what procedures to perform – potentially saving the patient's life. While current video technology is available, it is not reliable enough to guarantee the quality of service that is required in these settings.«

According to the 'LiveCity' team, other areas where this new technology could potentially prove useful include education, disease prevention, or more citizen-friendly civic administration. McCall concedes that »for many of these services a reliable interactive video link is required and this is precisely what is being addressed through the underlying technologies and example systems within LiveCity.«

SnT is interested in more than just the underlying video technology. »For example, the technology must be user friendly and integrate into everyday work or private life. These factors alone raise a number of questions about data privacy and security, which we will also explore within LiveCity,« says McCall.

SPELL: Satellite communication's 'lingua franca'

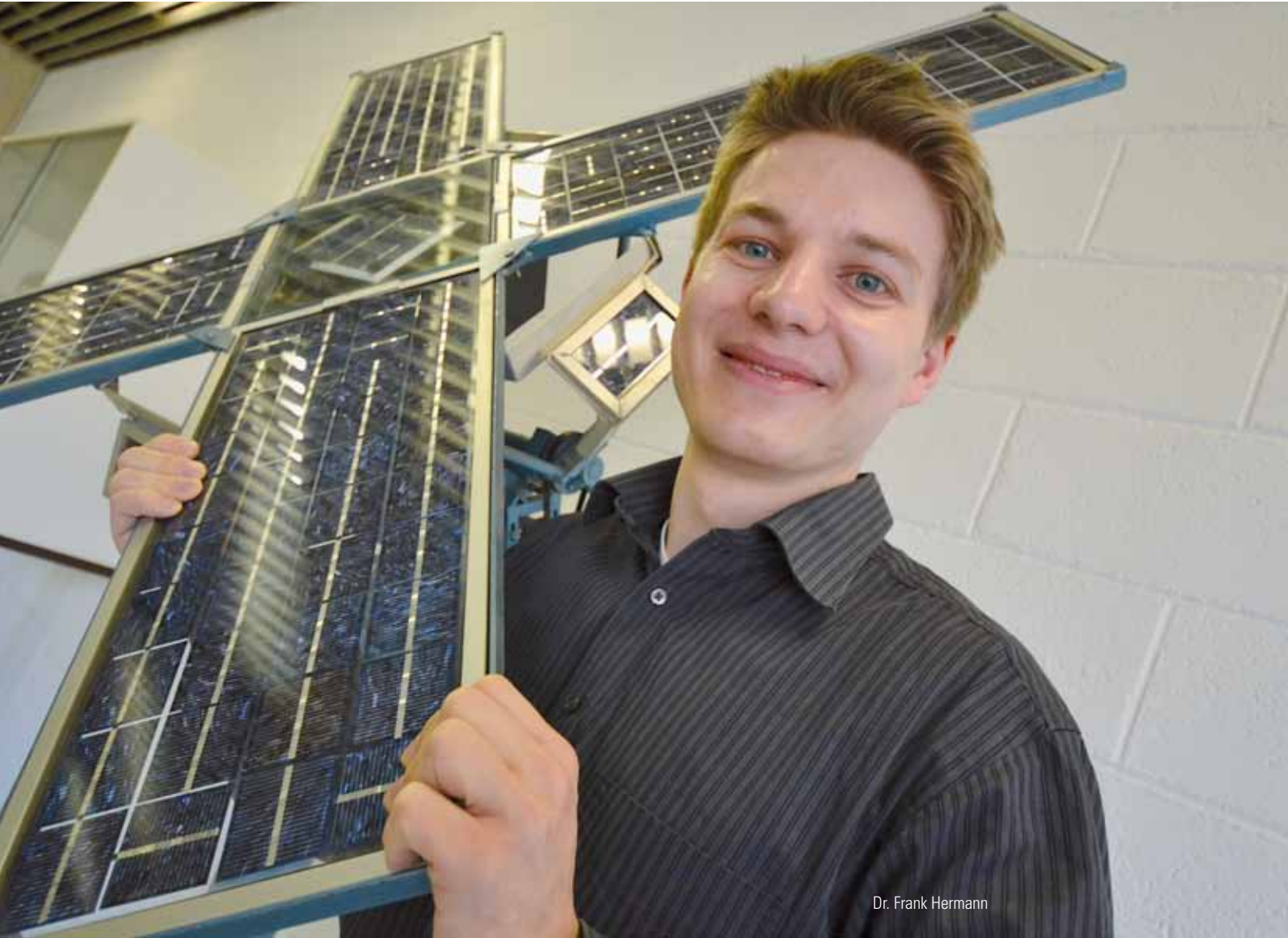


Frank Hermann is a theoretical computer scientist at SnT who works as a translator. However, it is not Luxembourg's great linguistic diversity - where English, German, and French all converge in the sciences - that keeps him gainfully employed. Instead, Hermann specialises in automatic translation of programming languages for satellite technology - a field that is highly relevant to Luxembourg-based SES, one of the world's leading satellite operators with a large fleet of satellites in orbit - and with new ones being added all the time. The satellites are all made by different manufacturers, who each use their own idiosyncratic programming language. »Because of this complete and utter lack of standard, operation and maintenance of the machines require an enormous amount of effort on our part,« explains Martin Halliwell, Chief Technology Officer at SES. »Our operators have to work with many different programming languages in order to successfully navigate the SES fleet through space.« This is especially

frustrating because the satellites don't usually forgive programming mistakes being made. »Mistakes like that could lead to our satellite getting lost in space,« Halliwell explains. »And as a result we incur millions in losses.«

This is why for some time now SES has been working on developing the open-source-software SPELL. The acronym stands for 'Satellite Procedure Execution Language & Library', a standardised satellite control language that allows operators to execute every imaginable control procedure of any ground control system for every potential satellite in the fleet. In other words - maximum flexibility with maximum security. »There is a catch to all of this, though« SnT-scientist Frank Hermann concedes. »All of the control procedures in existence that are being used in different programming languages have to be converted over to SPELL. If this process does not happen automatically and is not 100 percent mistake-free, the whole affair turns into a huge mess.«

However, this catch is actually somewhat of an incentive for a theoretical computer scientist with a specialty in triple-graph-transformations like Hermann. »This particular mathematical model has been around since the 1990s,« Hermann explains. »Along with other computational tools it actually turns out to be the ideal instrument to unite different programming languages under SPELL.« What is unique about the translational protocol that was developed by Hermann and his colleagues is that source code programming is not



Dr. Frank Hermann

necessary for translation. »Instead, we work with visual programming, where translational rules are being drawn into a graphic user platform,« says Hermann. These rules are executed automatically by special mathematical tools. A high-quality translation is guaranteed through automatic consistency testing. »Abundant mathematical evidence exists, which supports our approach,« Hermann confirms.

If the translation proceeds as planned, every piece of information in the original language is first converted into a graph. »This creates a network containing multiple subgraphs in the graphical interface,« explains Hermann. Next, the network is read and the sub graphs are translated into new sub graphs forming the resulting network, which is directly converted into the target language SPELL. »Every piece of information in the old language has its own SPELL counterpart,« the com-

puter scientist explains. »Our translation has to be highly precise because our goal is to ultimately have satellites that now run on SPELL control software and still act identical to their original version that ran on the old software.«

Since extensive empirical evidence exists in support of this protocol's ability to successfully retain this information, the results of the translational work may find their way into application sooner than later. »Our validation teams are in the process of confirming our results as we speak,« Martin Halliwell says optimistically. »If all goes well, our next satellite, which is scheduled for launch into orbit this summer, will start out running on SPELL.«

The team creates the success



Seven new EU projects, eight new strategic partnerships with companies, and sixty new employees, SnT is experiencing enormous growth. What are the reasons for this success, Prof. Ottersten?

Above all else, the team. I feel the employees at SnT are very highly motivated and that they support the developments. The advantage of such a young institution is that you can bring in scientists with lots of experience who know how to establish a good environment for the younger colleagues. They create room for personal fulfilment and convey responsibility without constraining with excessive bureaucracy. That way, everyone can personally develop to his or her best. And that in turn does good for all the rest. We have managed to do that at SnT.

Good motivation requires good communication...

... and transparency. Our budget, for example, is distributed internally according to clear priorities: first, projects from our strategic partnerships; next, projects running at the EU level; and, finally, projects with other funding sources. Only internal projects have the lowest priority. All scientists with budgeting responsibility are aware of that, which means they can account for it when acquiring projects.

How can you explain this order of priorities?

SnT's mission is to make a visible contribution to the scientific and economic diversification of Luxembourg. We are

also conducting basic research, which in the medium and long term leads to innovations in Luxembourg's technology companies. Projects in this vein therefore have highest priority. Another goal is to increase Luxembourg's international visibility in research. This in turn is best done in large, trans-frontier programmes like those in the EU. Projects from other funding sources are also important – if they support these two goals.

You managed to increase the number of strategic partnerships with companies significantly last year. But there are also public bodies involved, such as the City of Luxembourg or the CNPD, the Luxembourg data protection commission. Why is that?

Security, reliability and trust in ICT are not exclusive to economic activities. Far from it. Public authorities determine the general conditions that the economic sector has to comply with. That is why our collaboration with CNPD is so important: We learn of the challenges that legislators and regulatory bodies are facing and can offer our expertise at the same time. We are also internally reinforcing the link between technology – which is of course our greatest strength – and law. In turn, this benefits the technical developments we are advancing in collaboration with companies. Cooperation with the City of Luxembourg also serves as a far-reaching model: How do you increase the quality of life in an urban zone using information technology? We can set new standards for all of Europe here.



What are the challenges you are now facing?

We were extremely successful in acquiring partners and projects last year. Now we must press on to the work phase and, above all, deliver results. To do this, we will continue to increase our staff. The new employees must be well integrated; we need ample workspace for them. And naturally, the internal organization must be continually adapted to current demands. With 160 people, today's SnT is structured differently from the SnT of two years ago, with its then 60 employees – and the changes are continuing, so that everyone will always know what projects we are working on, what our objectives are, and how it all fits together.



Prof. Dr. Björn Ottersten

Two worlds collide



Newspapers, letters, television, radio, and telephone – twenty years ago, these were the most important venues of information and communication. Nowadays, our lives are dominated by the Internet. Many people spend nearly their whole day online. »Everyone who is networked in this way leaves behind a trail of data online,« says Gerard Lommel, president of the National Commission for Data Protection (CNPD). »Data protection has therefore taken on a new, fundamental significance, which concerns every single one of us, every day.« Data protection regulations therefore have to keep up with rapid technological advances while remaining beneficial to users, companies, and authorities – which is a considerable challenge. Luxembourg is pursuing new avenues towards a solution to this dilemma. Last year, SnT and CNPD entered into a strategic partnership with the intention of bringing together two formerly separate worlds – computer science and law.

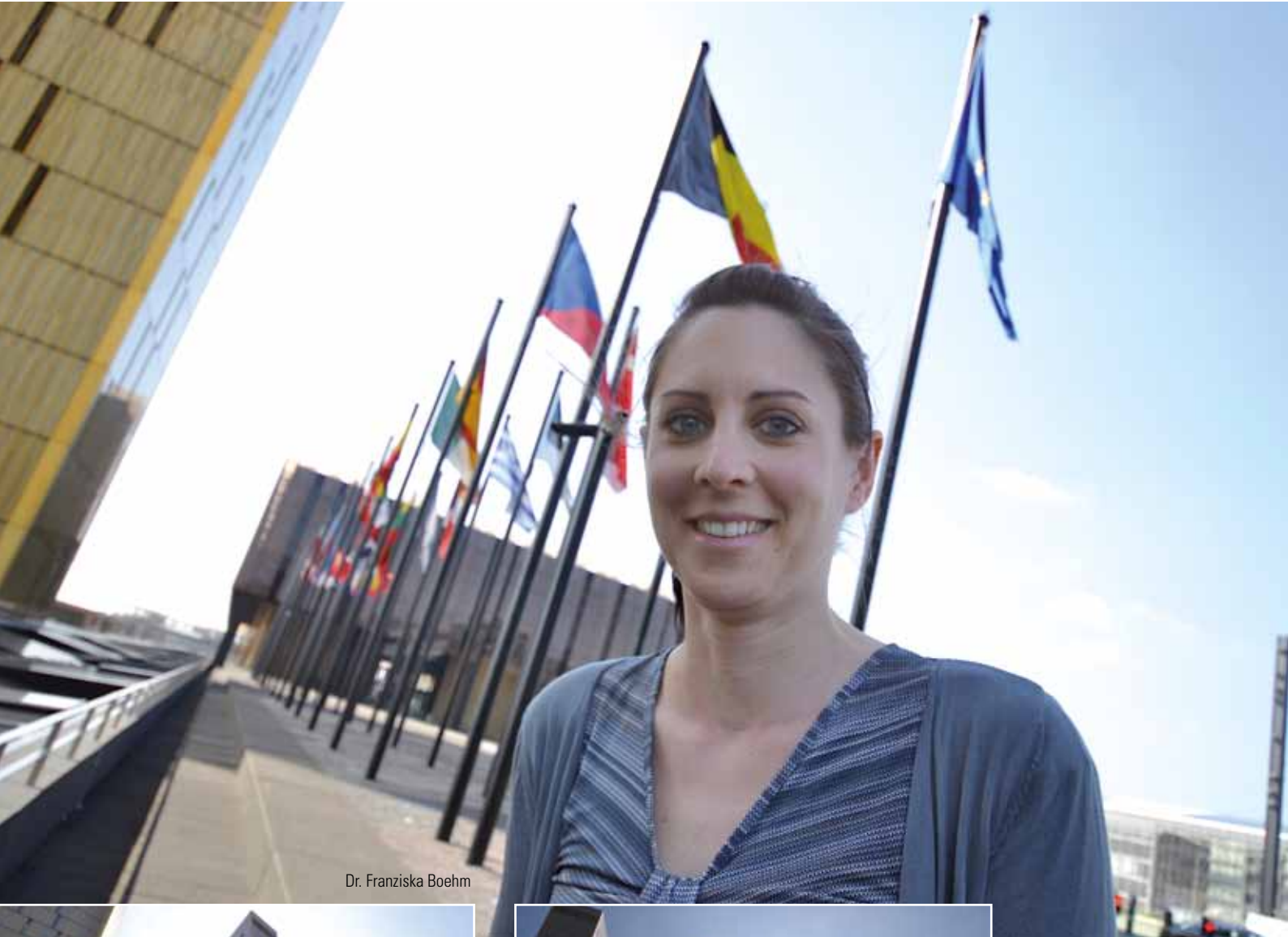
Mark Cole, the person in charge on behalf of SnT, is professor at the University of Luxembourg's Faculty of Law, Economics and Finance. »Almost every one of SnT's scientific or technological project – from new algorithms for automated people counters to those governing satellite technology – is somehow related to data protection,« says Cole. He views this as both a challenge and an opportunity. Privacy concerns must factor into the equation from the very beginning. Naturally, no one expects ICT specialists to all of a sudden turn into legal experts. »But here is a chance to establish a truly interdisciplinary approach at an early

stage and thus to establish another pillar of research of potentially broad interest at SnT,« says Cole.

The goal is that cooperation with CNPD will allow SnT to realise this vision. Within this framework, one person who works at both SnT and CNPD is in charge of mediating the daily exchange between the two organisations: Franziska Boehm, who holds a PhD in law. Her first and initially most important goal is to analyse the implementation of the new EU Data Protection Regulation in the fields that are of interest to SnT and CNPD. »The proposed new EU regulation is supposed to harmonise the different rules concerning data protection,« says Boehm.

The regulation introduces many reforms that will need to be considered. As is the case with every new legal norm, there is a certain latitude and room for interpretation as to how it can be applied. »Initially, I will be working with my colleagues at SnT and CNPD to identify the effects of regulation on data protection in Luxembourg and on information and communications technology, as well as, the scope of application,« explains Boehm.

CNPD president Gerard Lommel expects this analysis will take about a year to perform. »During the second year, we intend to see how this scope can be used legally and technically to increase the effectiveness and practicality of data protection in Luxembourg.« To this end, cooperating with SnT is of great importance to the CNPD. »We advise the government on implementing EU



Dr. Franziska Boehm



regulations, we furnish expert opinions to Parliament, and we specify the scope within which authorities and companies can move with regard to data protection legislation. It is therefore extremely important for us to take SnT's technological perspectives into account.»

Mark Cole describes the third and final step: »If we know how the EU Data Protection Regulation affects data protection, if it is clear how authorities and companies can specifically implement it, then SnT can help companies develop the necessary technologies.« Cole sees a

strong need for this, since globally active companies such as Amazon and eBay have their European headquarters in Luxembourg. They must factor the changes implicated in the EU Data Protection Regulation into their technology. »If, over the next few months at SnT, we manage to successfully bridge the gap between computer science and law, then SnT is destined to support these companies' future technological developments as they pertain to data protection.«

The software triad



Prof. Dr. Yves Le Traon

What do you do if your computer crashes? You probably turn it off and back on again and then carry on with your work. Maybe if you hadn't been saving the document you were working on, all your efforts of the past few hours would be lost. Aggravating? Yes, of course – but certainly not the end of the world! But how do financial service providers, airports, or nuclear power plant operators respond if a central computer programme suddenly freezes? All of a sudden, people's lives are at stake, the companies face potential monetary losses in the millions, or they compromise their economic viability. »On no account can such major systems of pivotal importance to our lives afford a major software failure,« says Yves Le Traon, SnT scientist and professor at the University of Luxembourg's Faculty of Natural Sciences, Technology and Communication. These systems must also run faultlessly during their normal operation. »Security, reliability and trust are of existential importance here.«

Because of this, as much as 60 percent of software development costs in this field go towards testing new or upgraded programmes. Because the programmes are much too large and complex to allow any one person to meticulously work through the programme code line by line, this type of work can only be performed, to a limited extent, by software developers – actual people in front of a computer screen. »We are addressing this issue in my research group SERVAL,« says Le Traon. The acronym stands for 'Security Design and Validation of Services and Networks.' Le Traon describes the idea

behind his group's approach in terms of a triad: formal mathematical methods, modeling, and testing.

»No matter how many automated processes you use to test these programmes, they simply cannot be completely tested,« says Le Traon. »The first thing to do, then, is find those places that are truly important and where errors may have crept in.« To identify these weak links, the SnT researchers are modeling the programmes' responses to changes in outside influences. To attain the greatest scientific validity, the team employs formal mathematical methods in the development of their model. As such, the scientists are creating a testbed, with the help of which the programme is put through its paces.

»Such methods are of great importance to Luxembourg as a financial centre,« explains Le Traon, emphasising his work's real world applicability. In fact, last year, SnT entered into a strategic partnership with CETREL, a globally leading provider of cashless transaction technology and IT services for the financial sector. In a restaurant or shopping mall, the customer presents a credit card, signs the slip, and the bill is settled in a matter of minutes. What the cardholder is completely unaware of is the fact that, quietly in the background, CETREL's computer programmes, which have to satisfy the most stringent security and reliability requirements, are busy processing hund-





reds of thousands of transactions per day – with a vast range of options banks offer to their credit card clients.

»In the real world, before software can be used for a new type of transaction, CETREL has to first identify and eliminate potential weak links,« explains Le Traon. To do this, test runs are conducted on a full business day's worth of transactions, which requires a great deal of effort. »We want to reduce the number of necessary transactions significantly through our automated testing,« says

Le Traon. This software triad of formal mathematical methods, modeling, and testing thus minimises effort and maximises efficiency while ensuring at least the same degree of reliability and security – so that you can rest assured that your credit card payments will never be declined because of some programme crashing.



Lionel Briand has been repeatedly ranked one of the top five software systems engineering researchers in the world by the Journal of Systems and Software. Endowed with a PEARL Grant from the Fonds National de la Recherche, he joined Luxembourg's SnT at the beginning of 2012. He is in the process of setting up a laboratory for software verification & validation (V&V) in collaboration with SnT's partners.

Our modern world and all industry sectors, from automotive to medical devices, increasingly depend on complex software systems. »They have become so complex that software engineers often have great difficulty ensuring an adequate level of dependability,« Lionel Briand says. »To deliver predictably dependable software-intensive systems in a reasonably cost-effective manner, we need proven software verification and test technologies that are highly automated.«

The view from outside

Martin Halliwell is Chief Technology Officer at SES S.A., Luxembourg, and a member of the Advisory Board of SnT. This body discusses the core strategic topics of SnT: science, organisation and finances. What are the economist's views on this body and the development of SnT?

Mr. Halliwell, how do you feel while driving to a board meeting?

Martin Halliwell laughs: I feel good! I like the atmosphere at SnT, which is one of open, creative and yet organized work. It is great talking with people who are involved in exciting science and who have good ideas. Believe me: this is no boring committee work.

You have witnessed the development of SnT since its inception. How would you rate what has been achieved so far?

Excellent – Björn Ottersten and his team are doing a wonderful job. If you think back two years, there was no SnT yet. And now we have an institute that is doing outstanding science, is networked with the economic system and is researching into relevant issues.

What were the most important decisions made along the way?

I think it is very important that SnT sought close contact with companies from the outset. The Partnership Programme is just the right instrument for that. It puts SnT right on the pulse, on what is important for the economy as well as for public establishments in ICT.



Dr. Martin Halliwell, CTO at SES

SnT's research also helps us enormously to maintain and increase our competitiveness. Almost no company could do internal research so relevant to practical application at the quality and to the extent of what they can do at SnT.

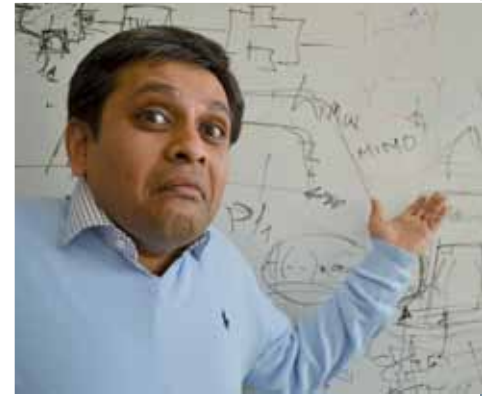
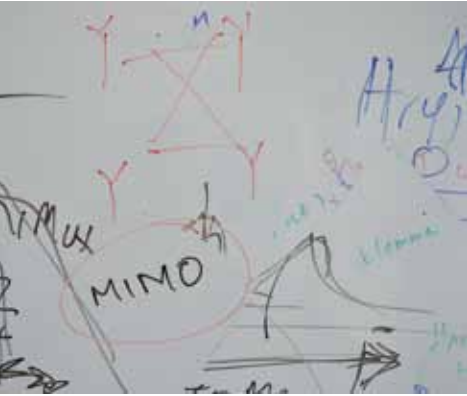
SnT is still growing fast. What should they bear in mind, in particular?

It is especially important to maintain the balance between experienced and young scientists. Last year, in particular, SnT acquired a huge number of projects that now have to be put into operation very soon. It is fitting and relatively easy to employ doctoral students or young post-docs for this. And so it should be – but we need people with a lot of scientific experience to be there as well, to steer the work in the right direction. This is an important issue that SnT is addressing.

How do you see SnT in the next three years?

SnT will continue to grow – the staff not so rapidly as in the first year, but there will be all the more scientific output for it. And SnT will become an increasingly important force that will greatly boost the performance of Luxembourg's technological companies.

Making satellite technology progress a reality



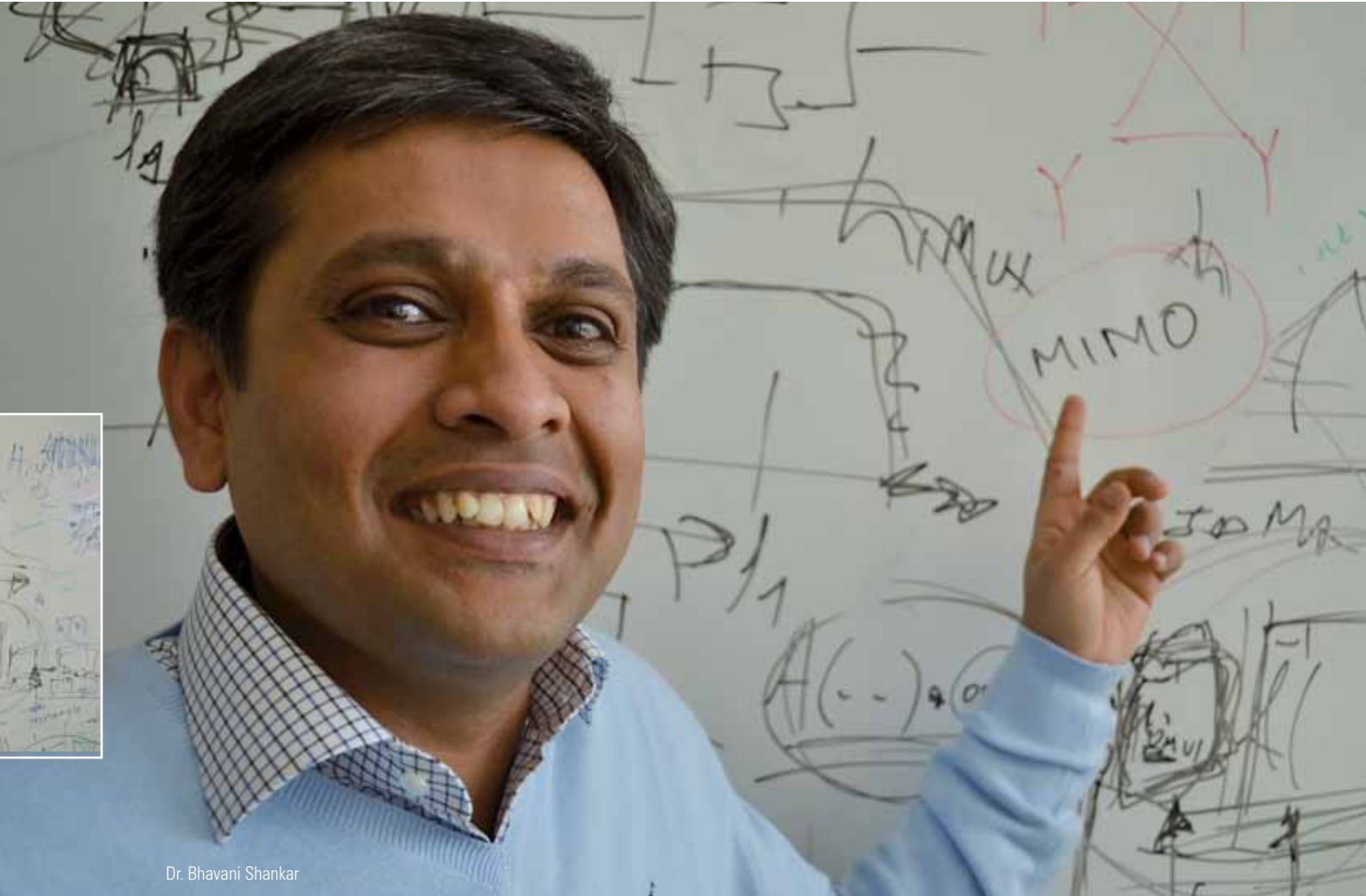
According to Dr. Bhavani Shankar, researcher at SnT, satellite designers tend to be conservative. Here is why: satellites are supposed to have a minimum 15-year lifespan. Once a satellite has been launched into orbit, it is practically impossible to make any after-the-fact changes to its hardware. If during operation it turns out that something was manufactured or put together incorrectly, for the operator this could mean incurring potential losses and damages exceeding several million Euros. »Which is exactly why manufacturers are so resistant to the idea of incorporating new technologies,« Shankar explains.

This is not the case with terrestrial communications. Because competition is stiff, cell phone manufacturers and wireless carriers need to be cognisant of always maintaining a technological edge. That is why MIMO - the acronym stands for 'Multiple Input-Multiple Output' - technology asserted itself a while ago. In the MIMO system, both broadcaster and receiver (for example, a cell phone) contain multiple built-in antennas for exchanging different types of signals whose content, though identical, may differ in terms of quality depending on the mobile user's physical location.

Even under challenging conditions - say, if blocked by a wall, the signal does not have sufficient strength - MIMO will ensure that users will typically get good reception on their mobile device.

In the field of satellite communications, however, MIMO has yet to catch on. Here, the potential technological risk deters manufacturers. However, Bhavani Shankar firmly believes that moving forward is essential for manufacturers to stay competitive: »Satellite operators have to keep up with technological advances if they wish to improve service to keep their customers happy.« The ESA, the European Space Agency, is in full agreement, which is why the Agency strongly promotes research and development of new satellite technologies like MIMO. For the MIMO project, SnT collaborated with SES, which operates a great number of satellites, and with Finnish partners: the University of Oulu on the software end; the business partner Elektrobit on the hardware end.

»Our objective was to develop a hardware demonstrator that uses a MIMO technology platform, and then try it out in a realistic setting similar to that of the actual satellite's,« Shankar explains. For



Dr. Bhavani Shankar

this purpose, a complete MIMO-based end-to-end system with broadcasting and receiving capabilities is being incorporated into the demonstrator.

»This way, the demonstrator simulates the most relevant features of the MIMO system - under conditions highly similar to those a satellite's receiver and sender are normally exposed to.«

In Fall 2011, SnT and Elektrobit handed the software of a demonstrator prototype over to ESA - which begs the question what ESA needs the demonstrator for seeing as the Agency is not itself a satellite manufacturer. »It allows for development and implementation of industry standards based on our demonstrator model,« Shankar explains. »If appropriate and reliable satellite technology standards exist that manufacturers can refer to, incorporating MIMO into the next generation of satellites will become much easier. Having this reference demonstrator will ultimately allow us to improve satellite transmission capacity and reliability while opening up new markets for commercial satellite operators.«

Björn Ottersten on EU and ESA projects

»For SnT, collaborating on EU and ESA projects is hugely important as such collaborations give our Institute greater international visibility. To secure funding for any potential research project, the stakes are exceedingly high. Each project we apply for, we have to be able to assure the granting agency - using scientific cases - that we are fully capable of handling the scope of the project. This is precisely the reason why a newcomer usually has such a tough time getting a footing in this field. In addition, there is fierce competition from the part of established research institutes. It is all the more impressive, then, that SnT, the new kid on the block, has already scored several major successes securing relevant projects. It underlines that SnT is made up of a diverse team of experienced scientists and young, highly motivated post-docs and doctoral candidates.«

International and interdisciplinary



»I immediately fell in love with Luxembourg and could easily see myself living here for many years,« says Alicja Gniewek. Agata Grzybek could not agree more. »Luxembourg has such an international flair that I don't at all feel like a foreigner here. The city really makes you feel at home.« Alicja Gniewek and Agata Grzybek both hail from Poland and both are PhD candidates who have been working at SnT since Fall 2011. Both share an air of contentment and enthusiasm, which suggests they must have been off to a good start at SnT. Alicja Gniewek's impression is that »SnT promotes this very open atmosphere - people are constantly talking to each other about their work.« It is this atmosphere of open exchange, which has quickly helped her settle into working at SnT and concentrate fully on her work. Whenever one hears the two scientists discuss the scope of the research they have mapped out for themselves for the next three years, one immediately gets the sense that unwavering concentration will be key to ensuring their success.

Alicja is a lawyer who first studied in Wroclaw, Poland, and who earned her Master's at the Universities of Luxembourg and Strasbourg. With EU law as her special area of expertise, Alicja is uniquely qualified for the work she does at SnT, a place where the fields of computer science and law intersect. The focus of her doctoral work is on identifying potential legal issues in cloud computing. Alicja is interested in figuring out the practical repercussions of laws and changing legislation on this modern-day data storage system. A central question that drives her research is determining how to ensure data privacy if data are now being stored across borders - a vast research domain, which Alicja, however, has quickly become familiar with, due in no small part to the Centre's unique atmosphere of free exchange of ideas and information.

Although both share a common national origin, Alicja, the lawyer, and Agata, the software designer, have not yet had a chance to collaborate. Not yet, as both



Alicja Gniewek and Agata Grzybek

are quick to emphasize. Agata studied in Poland and Denmark - as part of an Erasmus exchange program. After completing her studies, she worked in industry. Recently, Agata has found herself drawn to basic science research that has direct practical relevance. The software designer is concerned with examining how communication in vehicular networks can be improved. »Traffic control data processing is, for the most part, still very much a centralized process,« explains Agata. In a way, however, this is an anachronism since nowadays people and vehicles are connected to the Internet even when they are out and about. This could allow for exploitation of real-time data about a vehicle's movements and progression - all in the name of obtaining valuable information about traffic patterns and, ultimately, use that information to better guide traffic. For that to work, Agata and her colleagues have yet to find answers

to many questions, from fundamental properties of traffic patterns to the nature of communication protocols and legal issues regarding data privacy. Data privacy? But wait - doesn't that sound like a candidate topic for collaboration with Alicja? »Yes it does,« the lawyer confirms. »If our doctoral projects proceed as planned, I can imagine that we will end up working together.« Adds Agata: »Given SnT's spirit of collaboration, my guess is that it will probably just happen automatically.«

Communication as meta-level of distributed energy power grids

The amount of electricity generated from renewable sources is increasing. Experts estimate that by 2020 solar power will constitute around 40 percent of total electricity consumption. Sources for this energy include photovoltaic (PV) systems, which directly convert solar energy into electricity, and systems that use derived forms. Ultimately, even biogas plants, wind turbines, and hydroelectric plants represent renewable solar power generators.

»Such distributed energy generation is both sustainable and environmentally friendly,« says Jürgen Sachau, SnT researcher and professor at the University of Luxembourg's Faculty of Sciences, Technology and Communication. Twenty years ago, the Control and Systems Engineering Professor along with his then-department at the Fraunhofer Institute in Kassel, Germany, joined EUREC, the European Renewable Energy Agency. It was then that he and his team introduced the grid-compatible, modular PV system technology that has become today's standard. At the time, however, they could scarcely have imagined how rapidly PV would ultimately develop nor could they have predicted that total PV power usage in Europe would increase a thousand-fold. On the whole, solar electricity generators are now approaching an order of magnitude of the total grid capacity, theoretically making an economic, fully renewable power supply a viable option of the future.

However, this development poses major challenges for grid operators as an increase in the number of nodes can

potentially compromise network stability – something that is not the case with conventional, centralised electricity generation. »The Net Power Lab is concerned with exploring how grid stability and supply reliability can be guaranteed for up to 100 percent of renewable energy sources,« says Sachau, who was also lead monitor of the European PV demonstration programme.



But what exactly is it that makes managing stability of a grid that is fed by multiple distributed energy suppliers such a challenge? Plugging an appliance into an outlet connects the appliance to an extensive integrated power grid, fed primarily with electricity from centralised energy generators, the large power plants. These plants are decidedly slow to respond to any fluctuation in the grid because their huge generators cannot easily stop or start up again at a moment's notice. Although, at first, this may sound like a major disadvantage, it is actually a real plus for grid stability since abrupt fluctuations that might destabilize the grid do not normally occur. Yet this is precisely the danger a grid



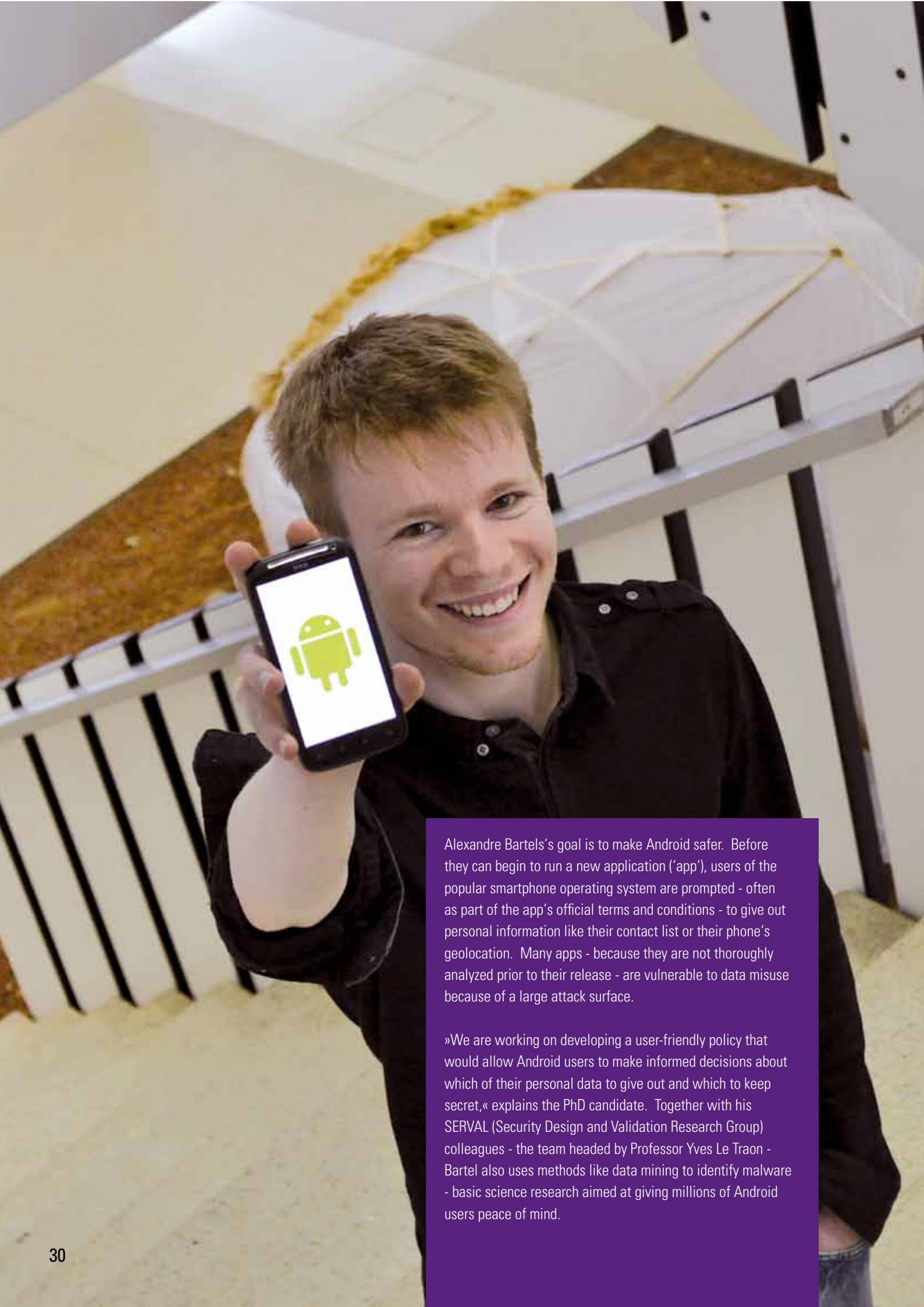
Prof. Dr. Jürgen Sachau

faces if it contains multiple distributed feeds that – as is the case with photovoltaic plants – are all affected by the grid's voltage fluctuations. According to Sachau's collaborator and PhD-candidate Markus Jostock, it is these fluctuations that are the Net Power Lab's research focus. »Photovoltaic plants use inverters to feed their electricity into the grid. Unlike large generators, inverters respond to changes in the grid within a matter of milliseconds.« This could potentially compromise grid stability, if, for example, instead of preventing power outages the inverters of multiple photovoltaic plants don't respond properly to failure of a major supplier.

This is where the Net Power Lab comes in – with an equally strong focus on both theory and practice. »In collaboration with the Luxembourg-based grid operator CREOS, we are currently in the process of computer modeling the dynamic behaviour of active distributed power grids. In order to optimise the components' response to power and communication demands, the grid behaviour of different types of connection points is reproduced dynamically in the lab – in real-time and real size,« Jürgen Sachau explains. The lab was also conceived to serve as a medium-term certification testbed to allow for the practical testing of theoretically-based demands that are placed on components like inverters.

The new infrastructure also adds an entirely new dimension: communication. »In distributed energy grids the nodes have to exchange information with each other and coordinate balancing processes in the grid as an interplay of hierarchically

distributed measures,« explains Sachau. This ensures that power outages are rare and locally restricted incidents and that they don't jeopardize neighbouring grids. In a way, the SnT researchers are entering the power grid's meta-level for which they, together with their partner laboratories of the DERLab, the European Network of Excellence, are laying the groundwork. The requirements for a communication network that is connected to the power grid are challenging since, according to Sachau, »it needs to be just as reliable as the power grid itself. The communication networks also have to meet the most stringent security requirements so that outside attacks neither interfere with nor cripple them.« This requires close cooperation with SnT's IT security experts. According to Jürgen Sachau, »the Net Power Lab's top priority is working on systems reliability and security issues in communications technology.«



Alexandre Bartels's goal is to make Android safer. Before they can begin to run a new application ('app'), users of the popular smartphone operating system are prompted - often as part of the app's official terms and conditions - to give out personal information like their contact list or their phone's geolocation. Many apps - because they are not thoroughly analyzed prior to their release - are vulnerable to data misuse because of a large attack surface.

»We are working on developing a user-friendly policy that would allow Android users to make informed decisions about which of their personal data to give out and which to keep secret,« explains the PhD candidate. Together with his SERVVAL (Security Design and Validation Research Group) colleagues - the team headed by Professor Yves Le Traon - Bartel also uses methods like data mining to identify malware - basic science research aimed at giving millions of Android users peace of mind.

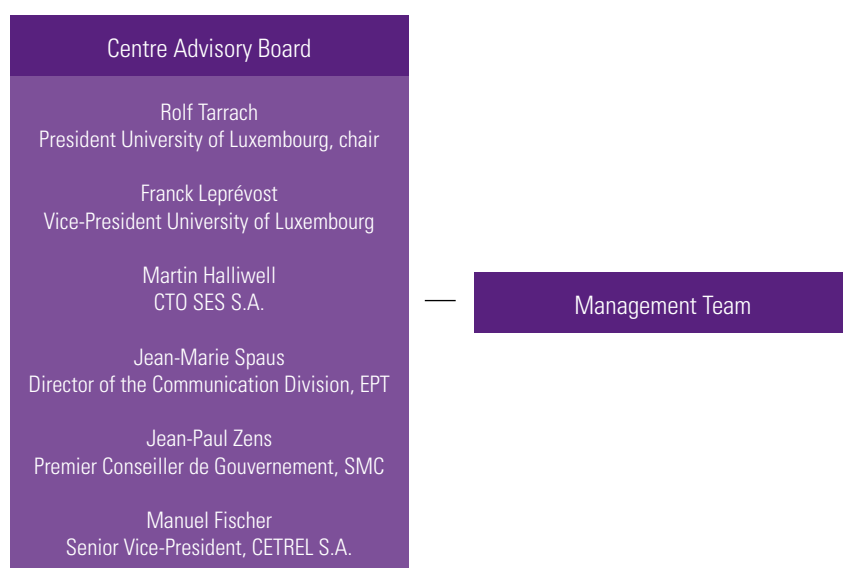
Organisation

Governance of SnT

A Centre Advisory Board, chaired by the President of the University of Luxembourg advises the President on the Centre's activities (strategy, annual plan,

A Scientific Advisory Board reviews the Centre's activities and provides input and recommendations on future

activities. The Director is appointed by the University's board of governors and is responsible for day-to-day management.



Organisation of SnT

The Industrial Advisory Board (IAB) brings together representatives from Centre partners. The IAB advises the Centre management on strategic issues and provides a platform for launching

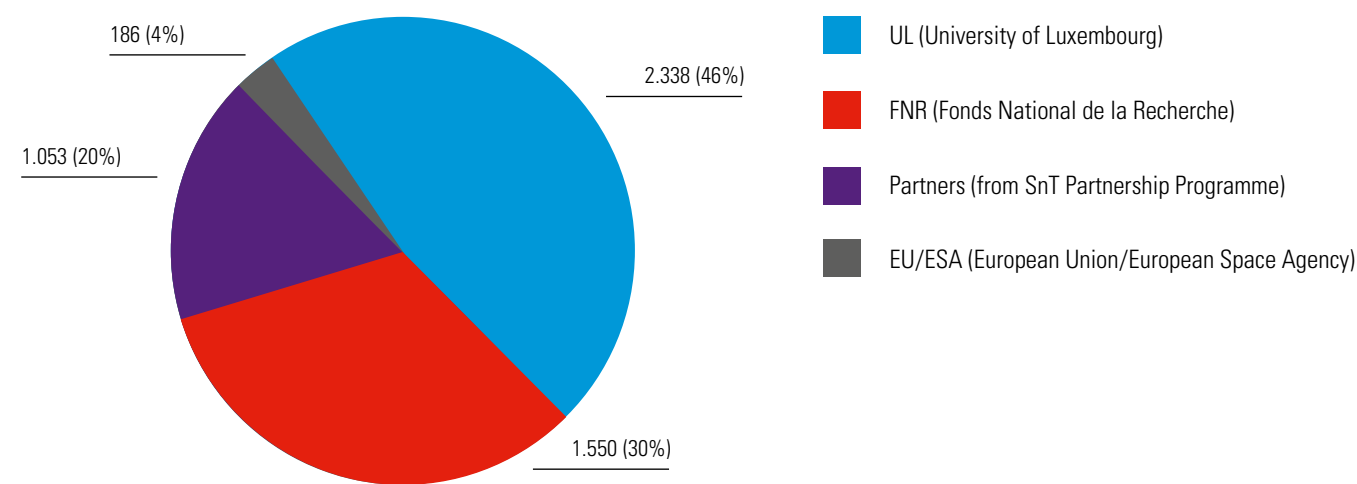
joint research projects. Research activities are primarily carried out in three application areas covering Security, Reliability and Trust in:

1. Enterprise Security
2. Services and Content including e-Government
3. Communication and Network Infrastructures

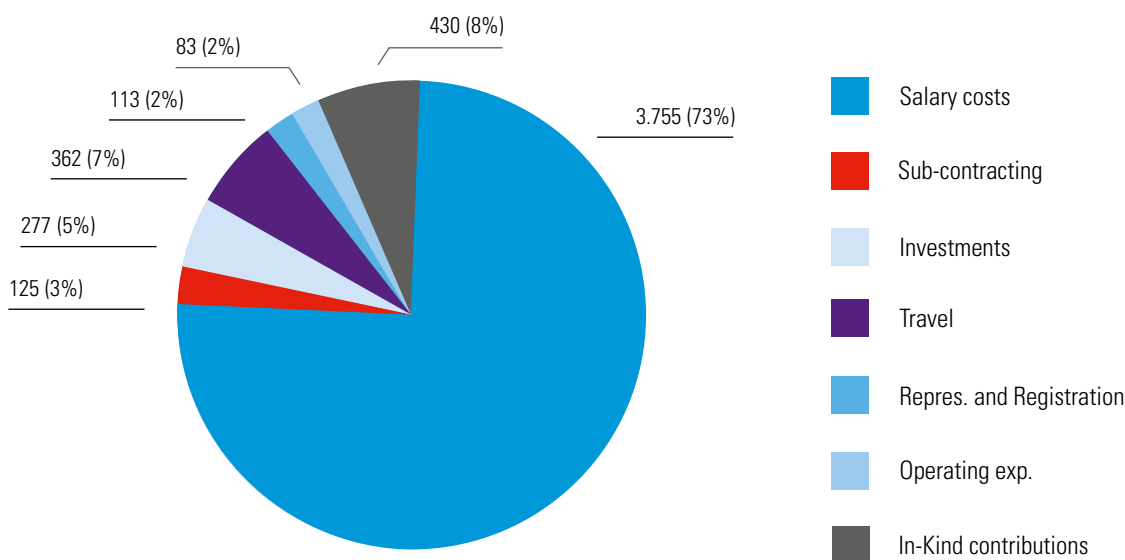


Financial data

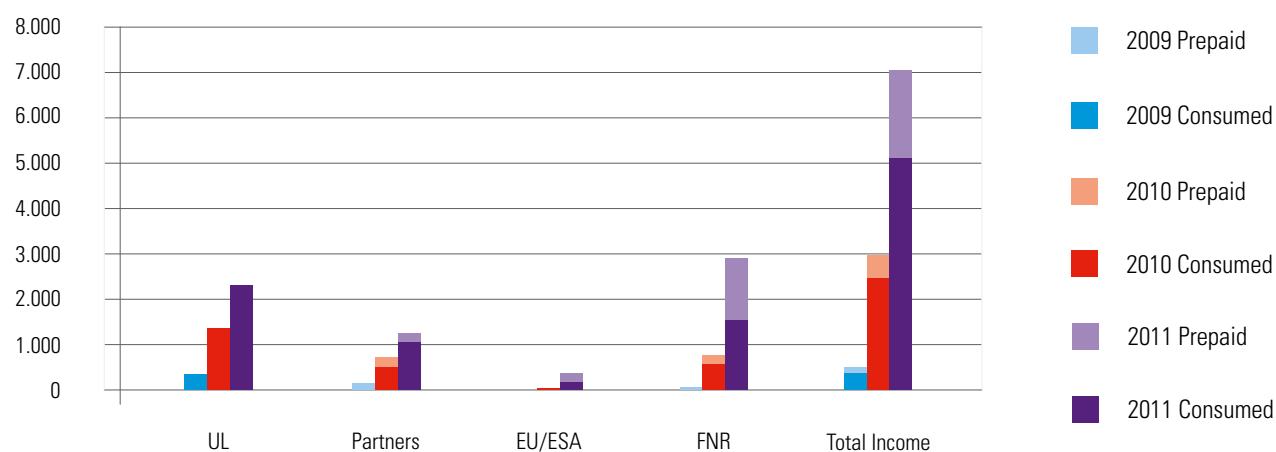
2011 SnT consumed income (in kEUR)



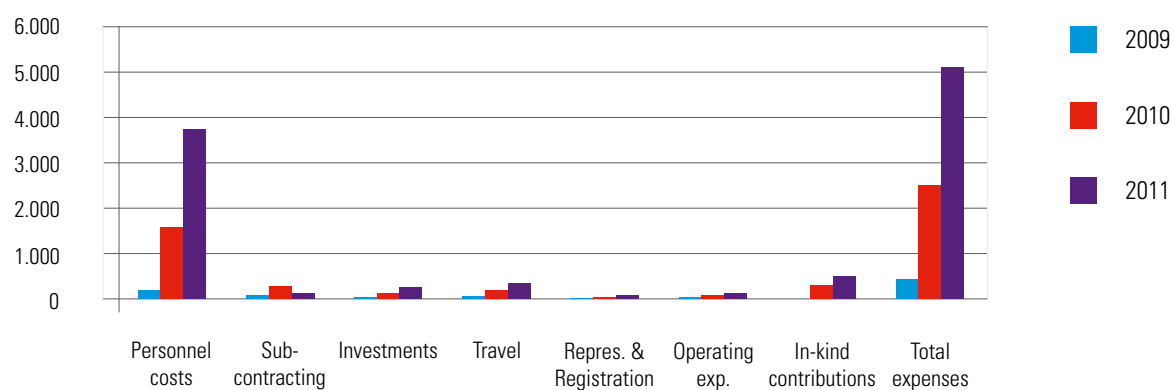
2011 SnT expenses (in kEUR)



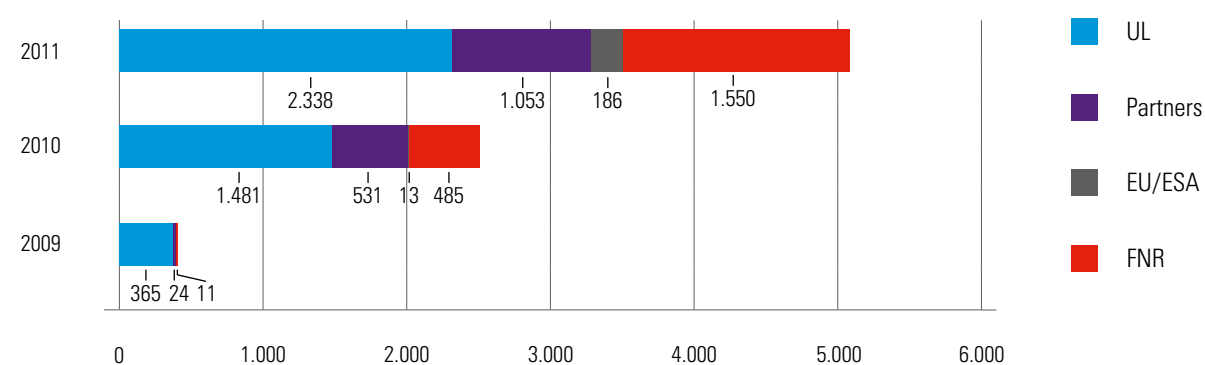
SnT 2009-2011 consumed and prepaid income per source (in kEUR)



SnT 2009-2011 expenses per category (in kEUR)



SnT 2009-2011 expenses per funding source (in kEUR)



People and awards

Faculty

- > Prof. Dr. Björn OTTERSTEN, Director
- > Prof. Dr. Thomas ENGEL, Vice-director
- > Prof. Dr. Alex BIRYUKOV
- > Prof. Dr. Pascal BOUVRY
- > Prof. Dr. Lionel BRIAND
- > Prof. Dr. Mark COLE
- > Prof. Dr. Mahulena HOFMANN
- > Prof. Dr. Pierre KELSEN
- > Prof. Dr. Yves LE TRAON
- > Prof. Dr. Romain MARTIN
- > Prof. Dr. Sjouke MAUW
- > Prof. Dr. Charles MAX
- > Prof. Dr. Peter RYAN
- > Prof. Dr. Jürgen SACHAU
- > Prof. Dr. Christoph SCHOMMER
- > Prof. Dr. Leon VAN DER TORRE
- > Prof. Dr. Holger VOOS

Research scientists

- > Dr. Jacques KLEIN
- > Dr. Vincent KOENIG
- > Dr. Radu STATE

Research fellows

- > Dr. Jacques BUS
- > Dr. Joao DA SILVA
- > Prof. Dr. David FOFI
- > Paul HELMINGER
- > Dr. Christoph MEINEL
- > Carlo SIMON

Staff

- > Stéphanie ANNET, Communications and events assistant
- > Laurent BETRY, Financial controller
- > Isabelle CHESNAY, Project coordinator
- > Ragga EYJOLFSDOTTIR, Administrative assistant
- > Marie-France GALLO, HR assistant
- > Dirk HANS, Communication

- > Magali MARTIN, Administrative assistant
- > Nathanaëlle MINARD, Project coordinator
- > Stefanie ÖSTLUND, Project coordinator
- > Dr. Cécile PETIT, Project coordinator
- > Dr. Jean SCHWEITZER, Project development manager

Technical support

- > Alexios ARAVANIS
- > Marco NEY, Engineer
- > Piotr KORDY, Engineer

PhD candidates

- > Zohair ABU SHABAN
- > Kassem AL ISMAEIL
- > Alexandre BARTEL
- > Benoît BERTHOLON
- > Sheila BECKER
- > Fabien BOULEAU
- > Ilya BILIBIN
- > Xihui CHEN
- > Dimitrios CHRISTOPOULOS
- > Silvano COLOMBO TOSATTO
- > Cesar DIAZ
- > Lautaro DOLBERG
- > Vasileios EFTHYMIOU
- > Markus FORSTER
- > David FOTUE
- > Rosario GIUSTOLISI
- > Alicja GNIEWEK
- > Agata GRZYBEK
- > Susann GOTTMANN
- > Mateusz GUZEK
- > Christopher HENARD
- > Stefan HOMMES
- > Llio HUMPHREYS
- > Sari Haj HUSSEIN
- > Markus JOSTOCK
- > Shree SHARMA KRISHNA

- > Samuel MARCHAL
- > Hrag MARGOSSIAN
- > Symeon MEICHANETZOGLOU
- > Jorge Augusto MEIRA
- > Assaad MOAWAD
- > Maximilien MOUTON
- > Nico NACHTIGALL
- > Yves NEISIUS
- > Phu Hong NGUYEN
- > Fabian LANZE
- > Roberto PIAZZA
- > Frederic PINEL
- > Mikolaj PODLASZEWSKI
- > Thorsten RIES
- > Arnab ROY
- > Sandra SCHMITZ
- > Patrick SCHWEITZER
- > Tim SCHWICKART
- > Eleftherios SKOUTARIS
- > Apostolos STATHAKIS
- > Cynthia WAGNER
- > Shaonan WANG
- > Pouyan ZIAFATI

Researchers

- > Dr. Djamilia AOUADA
- > Dr. Daniel Pantelis ARAPOGLOU
- > Dr. Franziska BOEHM
- > Dr. Benjamin BRAATZ
- > Dr. Patrice CAIRE
- > Dr. Martin CAMINADA
- > Dr. Florin CAPITANESCU
- > Dr. Symeon CHATZINOTAS
- > Dr. Thibault CHOLEZ
- > Lara CODECA
- > Dr. Jianguo DING
- > Dr. Bernabé DORRONSORO
- > Dr. Yehia ELRAKAIBY
- > Dr. Jérôme FRANCOIS
- > Dr. Raphaël FRANK
- > Dr. Frederic GARCIA BECERRO

- > Dr. Gabriela GHEORGE
- > Dr. Frank HERMANN
- > Dr. Martin HLAVAC
- > Dr. Ralf HOBEN
- > Dr. Dalia KHADER
- > Dr. Dzmitry KLIAZOVICH
- > Dr. Barbara KORDY
- > Dr. Simon KRAMER
- > Latif LADID
- > Dr. Jean LANCRENON
- > Dr. Juan Luis JIMENEZ LAREDO
- > Dr. Gabriele LENZINI
- > Dr. Qin MA
- > Dr. Roderick MCCALL
- > Aurel MACHALEK
- > Dr. Hani MEHRPOUYAN
- > Dr. Foued MELAKESSOU
- > Dr. Tejjeddine MOUELHI
- > Dr. Gregory NAIN
- > Dr. Maria Rita PALATTELLA
- > Dr. Andriy PANCHENKO
- > Dr. Michail PAPADAKIS
- > Dr. Thea PEACOCK
- > Dr. Johan PIGNÉ
- > Dr. Sasa RADOMIROVIC
- > Dr. Peter SCHAFFER
- > Dr. Marcin SEREDYNSKI
- > Dr. Bhavani SHANKAR
- > Dr. Julien SCHLEICH
- > Dr. David SCHULER
- > Yu-Youn SONG
- > Dr. Alexandru TANTAR
- > Dr. Ralf-Philipp WEINMANN
- > Dr. Gan ZHENG
- > Dr. Andreas ZINNEN

Visitors

- > Prof. Dr. Guido BOELLA,
University of Torino
- > Dr. Meng QINGMIN

MS students

- > Lopez José Miguel LOPEZ BECERRA
- > Walter BRONZI
- > Ana Maria GAGGERO
- > Loïc GAMMAITONI
- > Anna GIANNAKOU
- > Caroline HALEMBERT
- > Alexandrina KOVACHEVA
- > Diana MAROSIN
- > Luke SCOTT
- > Georgios ZIAZOPOULOS

Awards

Best paper awards

A New 1-D Colour Model and its Application to Image Filtering, Frederic Garcia, Djamila Aouada, Bruno Mirbach, Bjorn Ottersten, IEEE 7th International Symposium on Image and Signal Processing and Analysis (ISPA 2011), Dubrovnik

Cleaning Your House First: Shifting the Paradigm on How to Secure Networks, Jérôme Francois, Giovane Cesar Moreira Moura, Aiko Pras, Conference on Autonomous Infrastructure, Management, and Security (AIMS 2011), Nancy, France

Three songs and you are disconnected from cyberspace? Not in Germany where the industry may turn piracy into profit, Sandra Schmitz, Thorsten Ries, 6th Annual Conference of the British & Irish Law, Education and Technology Association (BILETA), Manchester Metropolitan University School of Law, 2011

Computational Framework for Optimal Robust Beamforming in Coordinated

Multicell Systems, Gan Zheng, Emil Björnson, Mats Bengtsson, Björn Ottersten, Fourth International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP 2011)

Individual awards

Professor Yves Le Traon received the prestigious **Ten Year Most Influential Paper Award** at the Models 2011 conference for the highly cited paper Refactoring UML Models - The Unified Modeling Language. Modeling Languages, Concepts, and Tools, Gerson Sunyé, Damien Pollet, Yves Le Traon and Jean-Marc Jézéquel, in Lecture Notes in Computer Science, 2001, Volume 2185, «UML» 2001.

A **Fulbright Scholarship** has been awarded to Sheila Becker, PhD candidate for a one-year research visit to Purdue University, USA to pursue research on virtual coordinate systems.

Projects

Partnered projects

Project name	Principal investigator	Researcher(s)	Partner
Research Program in Satellite Systems	SnT Program	Dr. D. Arapoglou, Dr. G. Zheng, Dr. S. Chatzinotas	SES
Planning of Payload Reconfiguration	Prof. P. Bouvry	Dr. G. Danoy, A. Stathakis	SES/AFR-FNR
Spread spectrum measurement system	Prof. B. Ottersten	Dr. S. Chatzinotas	SES/LuxLaunch
Satellite communication networks for mobile users	Prof. B. Ottersten	Z. A. Shaban, R. Piazza	SES/AFR-FNR
PIL to SPELL conversion	Prof. T. Engel	Dr. F. Herrmann, Dr. B. Braatz	SES
Refactoring and Semantical Correctness	Prof. T. Engel	S. Gottmann	SES
Model translation and model visualization	Prof. T. Engel	N. Nachtigall	SES
Research Program in Vehicular Networks and Smart Homes	SnT Program	Dr. R. Frank	EPT
Multimedia Sensor Networks	Prof. T. Engel	S. Hommes	EPT/AFR-FNR
End-to-end Web service security in Aspect Oriented Programming	Prof. T. Engel, C. Meinel	S. Wang	EPT
Pilot Study on Cloud computing in Financial sector in Luxembourg	Prof. T. Engel	Dr. A. Zinnen	BCEE
Challenges facing Cloud Computing. Legal assessment with special consideration of data protection and intellectual property law, including a case study of the banking and financial sector.	Prof. M. Cole	A. Gniewek	BCEE/AFR-FNR
Research Program in Multi-Sensor Fusion	Prof. B. Ottersten	Dr. D. Aouada	IEE S.A.
2D/3D Sensor Fusion	Prof. B. Ottersten	F. Garcia-Becerro	IEE S.A./AFR-FNR
Research Program in Resilient Infrastructures for Financial Transactions			CETREL
Statistical Manifold Learning for Fraud Detection	Prof. B. Ottersten	Dr. D. Aouada, Dr. C. Schommer	CETREL
Product differential testing from a product line	Prof. Y. Le Traon		CETREL
Smart honeypots for tracking fraudulent malware	Prof. T. Engel	S. Marchal	CETREL
From daily test traffic to a minimum subset of dissimilar test cases	Prof. Y. Le Traon	C. Hénard	CETREL
Research Program in Smart City - Urban sensing			Ville de Luxembourg
Usability Assessment of the City Administration ICT	Prof. Y. Le Traon		Ville de Luxembourg
Energy Optimization and Monitoring in Wireless Mesh Sensor Networks	Prof. T. Engel	D. Fotue	Ville de Luxembourg /AFR-FNR
Measuring the security reputation of intermediaries used by mobile devices to connect to wireless networks	Prof. T. Engel	F. Lanze	Red Dog Communications/ AFR-FNR
Trusted Location Services for Managed Community Networks	Prof. T. Engel	Y. Neisius	Telindus/AFR-FNR

Partnered projects

Project name	Principal investigator	Researcher(s)	Partner
Secure and private location proofs/architecture and design for location based services	Prof. S. Mauw	X. Chen	itrust/AFR-FNR
Legal Issues in Data Protection, Cloud Computing and Privacy	Prof. M. Cole	Dr. F. Boehm	CNPD

EU projects

Project name	Principal investigator	Researcher(s)
ceFIMS - Coordination of the European Future Internet forum of Member States	Prof. T. Engel	L. Ladid
OUTSMART - Provisioning of urban/regional smart services and business models enabled by the Future Internet	Prof. T. Engel	Dr. J. Francois, Dr. M.-R. Palatella, Dr. A. Panchenko
BUTLER - uBiquitous, secUre inTernet-of-things with Location and context-awareness	Prof. T. Engel	Dr. T. Cholez, Dr. F. Melakessou
IoT6 - Universal Integration of the Internet of Things through an IPv6-Based Service-oriented Architecture enabling heterogeneous components interoperability	Prof. T. Engel	Dr. A. Zinnen L. Ladid
GEN6 - Governments Enabled with IPv6	Prof. T. Engel	Dr. F. Melakessou, Dr. G. Gheorghe, L. Ladid
LiveCity - Live Video-to-Video Supporting Interactive City Infrastructure	Prof. T. Engel	Dr. R. McCall, Dr. T. Avanesov (to come)
FRESIC - FREE Secure Interoperable Communications	Prof. T. Engel	A. Machalek, Dr. R. Hoben
Web2LLP - Improving web strategies and social media presence of LLP projects	Prof. C. Max	J. Song
IPv6 Deployment Monitoring	L. Ladid	L. Ladid
SECRICOM - Seamless Communication for Crisis Management	Prof. T. Engel	A. Machalek

ESA projects

Project name	Principal investigator	Researcher(s)	Partner
MIMO Hardware Demonstrator	Prof. B. Ottersten	Dr. B. Shankar	SES
Techniques and Technologies for multi-spot beam Ku-band Satellite Networks	Prof. B. Ottersten	Dr. B. Shankar, A. Aravanis	EADS-Astrium
LASP - Developing a prototype of Location Assurance Service Provider	Prof. S. Mauw	X. Chen, Dr. G. Lenzini, Dr. J. Pang	itrust
Dangerous Goods Transport Tracking and Tracing in the Medical Sector	Prof. Y. Le Traon	Dr. T. Mouelhi	ESA
On-ground multi-carrier digital equalization / pre-distortion techniques for single or multi gateway applications	Prof. B. Ottersten	Dr. B. Shankar	ESA

FNR CORE projects

Project name	Principal investigator	Researcher(s)	Partner
ATREES - Attack Trees	Prof. S. Mauw	Dr. B. Kordy, Dr. S. Radomirovic	
SeSaNet - Integrated Security and Safety Engineering for Networked Control Systems*	Prof. H. Voos	R. State, J. Francois	CRAN – Université Lorraine, Mouhamed Darouach
CoPAINS - Conviviality and Privacy in Ambient Intelligence Systems*	Prof. Y. Le Traon	Dr. P. Caire, Dr. Y. Elrakaiby	UCL
FAVE - Fusion Approaches for Visual systems Enhancement*	Prof. B. Ottersten	Dr. D. Aouada, Dr. F. Garcia-Becerro, K. Al Ismaeil	IEE, Université de Bourgogne
STAST - Socio-Technical Analysis of Security and Trust*	Prof. P. Y.A. Ryan, Prof. S. Mauw	Dr. G. Lenzini	University of Catania, Royal Holloway University of London, Newcastle University, UCL, Norwegian University of Science and Technology
REDESG - Reliable and Efficient Distributed Electricity Generation in Smart Grids*	Prof. J. Sachau	Dr. F. Capitanescu, M. Jostock, H. Margossian, I. Bilibin	CREOS (Luxembourg)
iGEAR - Incentives and Gaming Environments for Automobile Routing*	Prof. T. Engel	Dr. R. McCall, M. Kracheel, Dr. V. König, Dr. R. Reuter, Prof. R. Martin,	
LAAMI - Logical Approaches for Analyzing Market Irrationality	Prof. B. Ottersten	Dr. M. Caminada	LSF
MOVE - Mobility Optimization using Vehicular network technologies	Prof. T. Engel	Dr. R. Frank, Dr. A. Panchenko, Dr. J. François, M. Forster, M. Mouton, L. Dolberg	UCLA (Network Research Lab)
MITER - Modeling, Composing and Testing of Security Concerns	Dr. J. Klein	P. Nguyen	
CO2SAT - COoperative and COgnitive Architecture for SATellite Networks	Prof. B. Ottersten	Dr. S. Chatzinotas, Dr. G. Zheng, D. Christopoulos, Dr. D. Arapoglu	SES ASTRA
GreenIT - EnerGy-efficient REsource Allocation in Autonomic Cloud Computing	Prof. P. Bouvry	Dr. B. Dorransoro, Dr. J. Pecero	
MARCO - Managing Regulatory Compliance: a Business-Centred Approach	Prof. P. Kelsen, Prof. L. van der Torre	Dr. Q. Ma, S. Colombo Tosatto	
University of Surrey, University of Birmingham, University of Melbourne, IMT Lucca	Prof. P. Y. A. Ryan	Dr. D. Khader, Dr. G. Lenzini	University of Surrey, University of Birmingham, University of Melbourne, IMT Lucca

* All projects awarded in 2011 with starting date in 2012.

Events

Distinguished Lecture by Prof. Mark D. Ryan (University of Birmingham): Automatic verification of security and privacy properties, January 2011

Workshop on Location-based services & Privacy Assurance, February 2011

Distinguished Lecture by Prof. Nigel Smart (University of Bristol): Attestation: Trying to decipher what it is, February 2011

Distinguished Lecture by Prof. Steve Schneider (University of Surrey): Implementing Prêt à Voter, March 2011

Distinguished Lecture by Dr. Ricardo Di Gaudenzi (European Space Research and Technology Centre (ESTEC)): Satcoms 2020 R&D Challenges, May 2011

EVOLVE 2011 – A bridge between Probability, Set Oriented Numerics and Evolutionary Computation, May 2011

Vehicular Communications Workshop, May 2011

2nd Summit on the Future Internet, June 2011

Workshop on the New Internet Protocol version 6 (IPv6), June 2011

Workshop on Digital Government 2020 (e-Government services), June 2011

2nd Luxembourg-Polish Symposium on Security and Trust, June 2011

Distinguished Lecture by Prof. Luca Vigano (University of Verona): Automated Validation of Trust and Security of Service-oriented Architectures, June 2011

Distinguished Lecture by Prof. Maximilian Herberger (University of Saarland): Current Research Issues in Legal Informatics, June 2011

Dagstuhl-Seminar on Verifiable Elections and the Public, July 2011, co-chair: Prof. P. Y. A. Ryan

Distinguished Lecture by Prof. Dan S. Wallach (Rice University, Houston): Adventures in Electronic Voting Research, July 2011

1st Int. Workshop on Socio-Technical Aspects of Security and Trust, September 2011 (Co-located with 5th International Conference on Network and System Security), co-chair: Dr. G. Lenzini

SnT Strategy Workshop, September 2011

Distinguished Lecture by Prof. Carroll Morgan (University of New South Wales): Semantics for noninterference security: Rhyme and Reason, November 2011

The Open Web Application Security Project (OWASP-Day) BeneLux, December 2011

Publications

Journal publications

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6. Caminada, Martin; Carnielli, Walter; Dunne, Paul: Semi-Stable Semantics, Journal of Logic and Computation, Oxford University Press, 2011, pp. 1-45
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8. Chatzinotas, Symeon; Ottersten, Björn: Interference Mitigation Techniques for Clustered Multicell Joint Decoding Systems, EURASIP Journal on Wireless Communications and Networking, Special Issue on Multicell Cooperation for Next Generation Communication Systems, vol. 132, 2011
9. Chen, L; Wong, Kai-Kit; Chen, H; Liu, J; Zheng, Gan: Optimizing transmitter-receiver collaborative-relay beamforming with perfect CSI, IEEE Communications Letter, vol. 15, no. 3, 2011, pp. 314 – 316
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14. Chami, Mohammad; Voos, Holger: A MATLAB-based Application Development Using a 3D PMD Camera for a Mobile Robot, *7th International ASME/IEEE Conference on Mechatronics, Embedded Systems & Applications MESA 2011*, pp. 1-10
15. Chatzinotas, Symeon; Christopoulos, Dimitrios; Ottersten, Bjorn: Coordinated Multi-Point Decoding with Dual-polarized Antennas, *7th International Wireless Communications and Mobile Computing Conference*, 2011
16. Chatzinotas, Symeon; Ottersten, Bjorn: Clustered Multicell Joint Decoding under Cochannel Interference, *IEEE International Conference on Communications*, 2011
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2. Arapoglou, Pantelis-Daniel; Panagopoulos, Athanasios: A Tool for Synthesizing Rain Attenuation Time Series in LEO Earth Observation Satellite Downlinks at Ka Band, *EUCAP 2011*

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21. Dorronsoro, Bernabé; Bouvry, Pascal: Differential Evolution Algorithms with Cellular Populations, Parallel Problem Solving from Nature (PPSN), Lecture Notes in Computer Science, vol. 6239, Springer, 2011, pp. 320-330, ISSN: 0302-9743
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»Cryptography develops in cycles where researchers take on the role of both the attacker and the defender,« says Alex Biryukov, SnT scientist and University of Luxembourg professor. »New encryption methods are designed. If weaknesses are discovered following an attack, new and improved encryption methods become a necessity.« And the cycle - the focus of Biryukov's work at SnT - repeats itself.

The field of cryptography rests on the three pillars of confidentiality, integrity, and authentication. Data have to be protected in such a way that they cannot be wrongfully accessed by even very intelligent adversaries. Users should have the assurance that no one tampers with their data as they travel through computer networks. »These requirements exist in an area of tension between a desire for flexibility and speed of service on the one hand and one for data protection and privacy on the other,« explains Biryukov. This makes for a complex cosmos, in which Biryukov is seen as one of the lead actors.

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